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"Biomedical Applications Team"

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Quarterly Progress Report 2

15 September 1967 to 14 December 1967

Prepared for

National Aeronautics and Space Administration
Technology Utilization Division
Washington, D. C. 20546

CONTENTS

1.0 INTRODUCTION

This report covers the activities of the Biomedical Applications Team at the Research Triangle Institute, Research Triangle Park, North Carolina for the period 15 September 1967 to 14 December 1967. The Biomedical Applications Team is a part of the National Aeronautics and Space Administration's Technology Utilization Program. It has as its objectives the transfer of NASA technology into the fields of biology and medicine. Essentially, the applications team seeks to match problems that medical and clinical researchers may have with NASA technology resulting from space research and development that may provide solutions to these problems.

The Biomedical Applications Team at RTI is a multidisciplinary group with backgrounds and experience in engineering and the physical sciences. The basic instrument with which the team members seek to achieve transfers of technology is personal contact and discussion with biomedical researchers. To aid in problem identification, consultants are retained at the medical schools of Duke University, Wake Forest University, and the University of North Carolina to provide an interface or point of contact between the medical schools and the Biomedical Applications Team and also to identify researchers whose programs may possibly offer opportunities of technology transfer. To identify applicable technology that may provide solutions to specific problems, the applications team has available not only the varied background of its members but also free access of the information residing in the NASA Research Center Organizational Complex. This NASA information is obtained through 1) dissemination by technology utilization officers within NASA research centers of documents known as problem abstracts which accurately define the specific problem in engineering terminology (these documents are prepared by members of the Biomedical Applications Team after comprehensive discussions of the problems with the individual researchers), 2) high speed computer searching of the aerospace literature by means of contractual arrangements with the North Carolina Science and Technology Research Center, 3) personal contacts with the NASA scientists and researchers, and 4) perusal of the current literature by members of the Biomedical Applications Team.

In addition to the three medical schools at which consultants are retained, the Biomedical Applications Team at the Research Triangle Institute interacts with the following organizations as well:

the University of North Carolina Dental Research Center,
Rockefeller University, Monte Fiore Hospital,
Hospital for Special Surgery, New York City,
the Veterans Administration Hospital, Durham, North Carolina, and
the North Carolina State University at Raleigh, North Carolina.

2.0 REVIEW OF TEAM ACTIVITIES

2.1 New Contacts

2.1.1 Wake Forest College, Bowman-Gray School of Medicine

WF-30

During the quarter, discussions have been held with an investigator at the Bowman Gray School of Medicine, Wake Forest University, concerning a problem which involves the operation of a blood vessel constrictor which they have devised. The device is used in open chest surgery to bring about controlled constriction of a blood vessel in instrumented animals. The present device is unsatisfactory from several standpoints. First, it does not provide accurate control of the amount of constriction, and second, and perhaps even more important, it does not permit the constriction to be removed instantaneously. The procedure in using these constrictors which they presently employ is to slowly decrease the blood vessel opening by constricting it and to monitor its effect on the animal. They wish to proceed as far as possible without actually causing the death of the animal. The present device cannot be released quickly, so that, if they go too far in constriction, it is very possible that the animal will die before the constrictor can be removed. Since these animals are carefully controlled and well instrumented, they represent a considerable investment of time and money and are valuable to the researcher. It is very desirable that experiments of this nature can be terminated rapidly enough to permit recovery of the animal. This problem is related to a similar type of problem which has been encountered at Duke University and we have been evaluating

the possibility of considering the two problems as one. Careful consideration reveals, however, that the two are actually distinct problems because the operational precedures of the two institutions are different. In one case recovery of the animal is highly desired; in the other case the constrictor is not capable of release and may well cause the death of the animal. In addition, and even more important, the application at Wake Forest is only intended for use with open chest surgery while the one at Duke is to be permanently implanted with a controlled constriction over a long period of time. As a result further information is being gathered on this problem, and a problem abstract will be written.

WF-31

In November another researcher of the Bowman Gray School of Medicine, Wake Forest University, was contacted. One of his areas of interest involves the use of respirators to provide artificial breath rate and control on, not only those people with physical impairments which prevent operation of the lungs in a normal fashion, but also on those people who have a normal set of lungs which, through some external circumstance such as perhaps overdosage of narcotics, or other like events, the control mechanisms which regulate respiration are temporarily inactive. Over-ventilation of lungs is not only undesirable, it can be positively harmful. To resolve this problem the researcher is interested in a servo-loop control system to measure the partial pressure of oxygen and the partial pressure of carbon dioxide in expired gases from the lungs of patients using respirators and to control the operation of the respirator based upon the composition of the expired gases from the lungs. Efforts to accurately define the problem and its specific requirements are continuing, and when this phase is complete a problem abstract will be prepared.

2.1.2 University of North Carolina Dental Research Center

UNCD-11

During October Dr. J. J. Crawford of the UNC Dental Research Center was contacted. The objective of his research program is to identify and quantify the bacteria found in the upper respiratory tract and the oral cavity of a number of children with and without complete development of the nasal and palatal tissues. The research program is being carried out

by sampling a number of children on a regular basis. Since these children are regularly available, the accumulation of valuable information on the development and growth of bacteria in the respiratory and nasal passages in various conditions of nasal and palatal development is permitted. The program will last for 125 weeks, and on the average, six persons per week will be sampled. Samples are obtained from three areas on each person--the nose, the throat, and the midnasal pharynx. From these samples, cultures are grown, and the bacteria present are identified and quantified. The sampling technique now being used is uncomfortable and even painful to the children being sampled. The researcher is seeking a means of sampling bacteria in the nasal pharyngeal passage which is simpler and less unpleasant to patients than the currently used method. The presently used technique is as follows: a speculum is used to permit entry into the nasal pharynx through the nose. A small wire, usually aluminum, which has a ball of alginate wool on the end is passed through the speculum and into the nasal cavity. The ball of wool is made to come into contact with the tissue floor in the nasopharyngeal passage, thus collecting the bacteria. The swab is then removed and processed to obtain the bacteria cultures. A problem abstract has been prepared for this problem and has been submitted for approval.

In addition to the problem abstract which has been written for this particular problem area, we have conducted a search through STRC of the NASA literature on assay of microorganisms. The search yielded 117 total hits and of these 117 hits, 33 were of direct interest to the researcher. We have ordered abstracts on these publications for the researcher's evaluation. He is presently evaluating these abstracts prior to ordering those documents which are considered to be useful.

UNCD-12

In October a researcher at the UNC Dental Research Center was contacted. He is engaged in a research project which involves the analysis of the speech difficulties of children born with cleft palates. He is seeking by experimental measurements to determine the effects of various types of corrective measures on the speech output of the children. Many of these children who have cleft palate defects also have some sort of defect in their nasal passages as well. The degree of palate damage does not always correlate well

with the ability of the children to speak distinctly. He feels that the malstructuring of the nasal passage, by introducing greater resistance to air flow than normal, may be one of the causes of this indistinct speech. The rushing of the air through the passages which have various types of restrictions to flow introduces turbulence. He feels that this distorts the speech and reduces its intelligibility. He is interested in devising experiments to establish the relationship between nasal resistance and speech intelligibility. There are at least two areas in his research program which offer distinct problems which have high probability of being solved through the application of NASA technology. First, one of the basic measurements which he desires to make on these children is a measurement of subglottal pressure. Present techniques are so cumbersome and time-consuming as to be almost useless. They involve the use of an esophageal balloon which is inserted into the subglottal region and inflated. Each patient must be calibrated separately in order to derive meaningful measurements. Essentially a small pressure transducer is needed which can be inserted into the subglottal region to permit measurement of the air pressure present in this region. Use of the pressure transducer developed by Ames Research Center immediately came to mind as offering a highly probable solution to this problem. We are currently attempting to obtain material to fabricate one of these devices for demonstration purposes. We feel confident that this NASA development will solve the problem. However, in the interest of thoroughness, we have written the problem in problem abstract form and it has been submitted for approval. The other problem involves the analysis of speech from these children. Present techniques for recording the speech do not permit isolation of those sounds which come from the mouth and those sounds which come from the nose. The investigator is seeking a method to separate or resolve these sounds. Further information is being gathered on this problem prior to writing a problem abstract.

UNCD-13

The Dental School is presently in the process of specifying new equipment for their laboratories. One of the needed pieces of equipment is a dry heat sterilization unit of reasonably small size. They have not been able to locate a sufficiently wide source of supply for such units. We undertook a search of our vendor literature. A number of sources were

located and a list of 12 manufacturers who make dry heat sterilizers plus a list of 18 manufacturers of general purpose sterilizers as well as a list of 34 manufacturers of autoclaves was furnished. This list will permit procurement of information on the various types of sterilization units available, thus permitting choice of the unit which is most suitable for their purpose.

2.1.3 University of North Carolina Medical School

UNC-34

A device is needed for warming blood. Whole blood from the blood bank must be warmed to body temperature before it can be administered to the patient. Commercial blood-warmers leave much to be desired. They are heavy, unreliable, and potential shock hazards.

UNC-35

A new device for measuring CO_2 in exhaled breath is desired. The present instrument detects CO_2 via infra-red absorption, but it needs frequent calibration and is somewhat delicate.

The new device should have rapid response, enabling the measurement of percent CO_2 in each breath. Further, the sensor itself must be small, since space is at a premium around a patient's head on the operating table. The sensor must be inert to the somewhat corrosive anesthetic gases.

UNC-36

A device is needed to measure breath volume of patients on the operating table. The sensor must be small and must be inert to anesthetic gases. The instrument must be capable of measuring volumes of each breath, as well as integrating the volumes over a period of time. Instruments are available which purport to make these measurements, but they are adversely affected by moisture or else cost $2,000 -$3,000.

UNC-37

Prevention of orthostatic hypotension. Patients who have been in bed for extended periods of time are subject to orthostatic hypotension syncope. There is quite a bit of literature on the subject. One method of preventing the occurrence of syncope is by use of anti-gravity suits. One of the MD's

at UNC would like to try some G-suit experiments on his patients; however, we have not yet been able to obtain the suits.

2.1.4 Duke University Medical Center

During the preceding quarter the hyperbaric facility at Duke University was toured, and an initial attempt to identify technology-related problems was made. It was found that one of their greatest needs is that of a catheter-mounted pressure transducer. It is necessary that the transducer be vented so that it measures only relative pressure and, most importantly, that it be reliable. Presently available transducers have proved to be extremely unreliable and expensive. The optical transducer developed by Dr. Max Anliker at Ames should be very appropriate for this application. Progress with the optical pressure transducer will be discussed under DU-31 in Section 2.3.

DU-30

A new surgical technique being investigated at Duke University requires catheterization during surgery. A difficulty which has been encountered is clotting at and near the catheter. One possibility of reducing clotting is to graft heparin to the surface of the catheter which is made of polyeurethane.

In attempting to obtain information on heparin-grafting, a search of the literature at RTI uncovered three reports on research at Battelle describing two processes which appear to be applicable. To determine the exact composition of the catheters, Corbin Catheter Company, was contacted. It was learned that the manufacturer itself is about to make a heparinized catheter available commercially. This catheter will be evaluated before attempting to use completely new processes.

2.2 Problem Review

During this quarter a review of all the problems which have been documented by the Biomedical Applications Team was completed. The purpose of this review was to eliminate from the problems those problem areas which are no longer considered active. There are various reasons for which problems were classified as being inactive. Some of the reasons are: successful transfer, discovery of satisfactory solution which could not be transferred

for economy or other reasons, identification of NASA technology which is applicable but no means are available to demonstrate the technology to the researcher, possible useable technology identified but unacceptable to researcher, researcher has no further interest in problem. The problems which were closed are listed below:

AEI - 1	Multiple Electrode Implant for Communicating with Brain
DU - 2	Optical Scanning Concept
DU - 3	New Techniques for Constructing Safe and Efficient Hemodialyzers
DU - 4	Measurement of Small Temperature Changes
DU - 5	EMG Electrode Assembly for the Soft Palate
DU - 6	Correction for Latency in Vidicons
DU -10	Techniques for Monitoring Heart Rate, Rapid Changes in Blood Pressure, and Detecting Arrhythmias Directly and Automatically from Physiological Data
DU -13	Sources of K-42 Having Very High Specific Activity
DU -14	Spray-On Electrode
DU -15	Techniques for Analyzing Carotid Artery Pressure Pulse to Obtain Blood Flow Data
DU -17	Storage and Retrieval of Biomedical Text
DU -18	Special-Purpose, Real-Time Data Processing
DU -19	Low-Cost, Microminiaturized, Reliable Time-Multiplexing and Analog to Digital Electronic Equipment
DU -22	Method of Alternately Exposing Tissue to Two Separate Monochromatic Light Beams Having Different Wave Lengths at a Rate of 5,000 Cycles/Second
DU -25	A Signal-Conditioning and Multiplexing System for Multiple Electrode EKG Patient Monitoring
DU -26	Power Sources for Operating Prosthetic Appliances
DU -28	Fluid Dynamics of Sucrose Gap Chambers
MFH - 1	Special Materials to be Used in New Hospital Construction
UNC - 1	Oxygen Measurements in Gas Mixtures
UNC - 5	Inserting Needles into Veins
UNCD - 2	Method of Measuring Change and Width of Mandible When Closed and Opened
VA - 2	Implantable Catheters with Outside Diameter of Approximately 0.01 Inch

WF - 1 Audio Noise Generator

WF - 2 Ultrasonic Transducer Positioner

WF -11 Mechanical Joints, Extensions, etc., That Can be Used in Powered Prosthetics

WF -14 Spin Resonance Studies of Physiological Tissue which Has Been Exposed to Radiation

WF -15 Information on Damage to Physiological Tissue Exposed to Low Levels of Radiation

WF -25 Data Obtained in Ultrasonic Studies of Materials which May Relevant to the Understanding of Scattering of Ultrasonic Energy in Physiological Tissue

WF -26 Power Sources for Operating Prosthetic Appliances

In addition to the problem review and evaluation program, all of the active problems at the Bowman Gray School of Medicine, Wake Forest University, have been reviewed during this quarter. The investigator for every problem has been contacted by Dr. George Malindzak, our consultant at Wake Forest University, to determine (1) amount of current interest evidenced by the investigator on each problem, (2) the direction that further action on these problems should take, (3) the effectiveness of previous literature and information already furnished by the Biomedical Applications Team, and (4) those research programs in which progress has led to the identification of new problems or the modification of the requirements imposed by old problems.

2.3 Problem Summaries

The activities of the Biomedical Applications Team with respect to specific Biomedical problems are outlined in the following paragraphs.

UNCD-1 A Method of Producing Silver-Copper and Silver-Tin Alloys in Powder Form with Spherical Shape and with Particle Sizes of the Range of 2 to 4 and 6 to 10 Microns.

During this quarter we received a telephone call from Mr. Jim Benson of the Rocketdyne Division of North American Aviation concerning this problem. He informed us that under a NASA-sponsored program they have developed a method of making spherical metal particles in the 2 to 4 micron size range with greater than 50 percent yield. He is sending us further information

on the process, but it has not yet been received. From the telephone conversation, it appears that the process may well meet the technical requirements of this problem. Final evaluation must await receipt of detailed information on the process and its costs.

UNCD-3 A Means to Obtain Rapidly a Pictorial Representation of the Temperature Distribution of the Interior of the Oral Cavity in Humans.

Discussions on this problem with the investigator have continued. Previous efforts to locate a solution at Marshall Space Flight Center have not been successful. During this quarter a problem abstract has been prepared and has been submitted for approval.

UNCD-6 A Small Sensor to Measure Accurately the Surface Temperature of Human Teeth.

This problem has also been evaluated during this quarter, and a problem abstract has been prepared and submitted for approval.

WF-5 Technique for Direct Imaging of Ultrasonic Energy Patterns

During the preceding quarter, a technique for directly recording ultrasonic energy intensity patterns and reported in two reports obtained from an update of computer search #767 was found. These reports have been sent to Dr. F. L. Thurstone who is now an Associate Professor in the Biomedical Engineering Department at Duke University.

WF-28 Blood Flow Volume and Blood Flow Rate in Vascular Systems Using Indicator Concentration Methods.

Investigation of this problem began in the previous quarter. Additional discussions have been held with the investigators, and their experimental system has been observed in operation in order to clearly define the problem prior to writing a problem abstract. This activity has been concluded during this quarter, and a problem abstract has been written. The problem abstract has been approved. Distribution copies have been mailed. This particular problem has been difficult to specify for a retrospective search. However, we have conferred with applications engineers at the Science and Technology Research Center on several occasions about this problem. We are presently in the process of preparing a search strategy for the problem.

WF-29 An Electrode for Measuring Hydrogen Ion Concentration and Carbon Dioxide Partial Pressure in the Blood

This problem has also been discussed in greater detail this quarter, and a problem abstract has been prepared and submitted for approval. A retrospective search of the NASA literature has been initiated with the Science and Technology Research Center. In addition, two articles have come to our attention which are applicable to the problem as a result of our normal activities in screening on a manual basis the current literature and STAR bibliographies. These two articles, one of which is a NASA publication, have been furnished to the investigator who is presently evaluating their applicability.

DU-26 Simulation of Coronary Infarction in Experimental Animals

Small devices for stimulating coronary infarcts are frequently used in research directed toward evaluations of various techniques for treating heart disease. The presently used device consists of the renting of casein plastic, ameroid, which is placed around one of the arteries which supplies blood directly to the heart. Ameroid, when in contact with body fluids, absorbs water and swells. The plastic ring is surrounded by a stainless steel band. Thus constrained, it, in swelling, pinches the artery and reduces the flow of blood to a section of the heart thus producing an infarct. It has been observed, however, that the amount of time required for occlusion of the artery varies drastically and, as a result, introduces an additional variable factor which complicates the interpretation of experimental results.

It has been determined that the major difficulty is inherent in the geometrical design of this constrictor. This geometrical design problem has been corrected, and two experimental devices have been fabricated. Samples of ameroid which were used in fabricating these devices were obtained from Tenneco Chemicals Incorporated, and support for fabricating the devices is being supplied by Duke University. The operation of these devices is presently being evaluated both at RTI and Duke University. Details and characteristics of this constrictor will be reported following completion of each evaluation phase.

DU-31 Catheter Mounted Pressure Transducer

In Quarterly Report #1 we reported that an optical pressure transducer

which has been developed at Ames Research Center by Dr. Max Anliker represents an excellent approach to the measurement of pressure in heart chambers. During the preceding quarter we obtained through Mr. George Edwards three catheter tips which are necessary for the fabrication of experimental transducers. The fabrication of these tips requires special facilities and skills which exist at few research centers. As a result, we will be able to evaluate this new approach which offers the possibility of low expense and high reliability.

2.4 Summary of New Problems

During the quarter the following new problems have been defined. They are listed below. A detailed discussion of each problem is found in Section 2.1, New Contacts.

UNCD - 11 A Means of Sampling Bacteria in the Nasal and Sinus Cavities Which is Simpler and Less Unpleasant to Patients

UNCD - 12 A Pressure Transducer of Small Size to Measure Air Pressure in the Subglottal Region

UNCD - 13 An Economical, Dry Heat Sterilization Apparatus

WF - 30 An Improved Blood Vessel Constrictor

WF - 31 A Servo-Controlled System to Measure Partial Pressure of Oxygen and Partial Pressure of Carbon Dioxide in Expired Gases and to Control the Operation of Respirators

UNC - 34 A Device for Warming Blood

UNC - 35 A New Device for Measuring Carbon Dioxide in Expired Gases

UNC - 36 A Device to Measure Breath Volume of Patients on Operating Tables

UNC - 37 Prevention of Orthostatic Hypotension

DU - 29 Technique for Heparinizing Catheters

2.5 New Problem Abstracts

During the quarter the following new problem abstracts have been prepared:

UNCD - 3 A Means to Obtain Rapidly a Pictorial Representation of the Temperature Distribution of the Interior of the Oral Cavity in Humans

UNCD - 6 A Small Sensor to Measure Accurately the Surface Temperature of Human Teeth

UNCD - 11 An Improved Bacteria Sampling Technique

WF - 28 Blood Flow Volume and Blood Flow Rate in Vascular Systems Using Indicator Concentration Methods

WF - 29 An Electrode for Measuring Hydrogen Ion Concentration and Carbon Dioxide Partial Pressure in the Blood

Biomedical problem abstract WF - 28 has been approved for distribution. A copy of this abstract is included as an Appendix to this report.

2.6 New Information Searches

Three new information searches have been made this quarter: Assay of Microorganisms, Mechanism of Diapedesis, and Measurement of Oxygen and Carbon Dioxide in Blood and in Expired Air. A computer evaluation report for each of these searches follows.

COMPUTER EVALUATION REPORT

Biblio. # 1060

Problem Name & Number:

Title Search & RDC Number: Assay of Microorganisms 0395

Date Search Initiated: October 30, 1967

Descriptors:

Mouth	Actinomycetes	Meningitis	Counting
Mucous	Aerobe	Microbe	Cultivation
Nose	Anaerobe	Microbiology	Identification
Oral	Bacteria	Microorganism	Sample
Respiratory	Bacteriology	Pneumonia	Sampled Data
Respiratory System	Culture/Biol/	Staphylococcus	Sampler
Secretion	Diptheria	Streptococcus	Sampling
Sinus	Escherichia	Assay	
Throat	Klebsiella	Classification	

Date Search Received:

Number of Hits: 117

Date Documents Requested by Researcher: Nov. 16, 1967, Dec.11

Number of Documents Requested & List of STAR Numbers:

*N67-33408	N67-13259	N66-32622	*A66-81480
N67-21177	N67-12843	*N66-21421	A66-42676
N67-19107	N67-12250		A66-40505
N67-18081	N67-12847	N65-14455	A66-19087
*N67-17613		N63-10583	A65-81202
N67-15703		N62-17620	A65-32795
N67-14761	N66-39919	N62-16828	A65-80001
N67-14772	N66-36089	N62-17620	
N67-14771	N66-36058		
*N67-14248	N66-36043		

Degree of Relevance to Problem: Asterisked documents were considered to be very relevant.

Plans for Use of Information: ---

COMPUTER EVALUATION REPORT

Biblio. # 1021

Problem Name & Number:

Title Search & RDC Number: Mechanism of Diapedesis

Date Search Initiated: September 28, 1967

Descriptors:

Hematopoiesis	Differentiation
Hematopoietic system	Stem
Bone Marrow	Primitive
Reticulocyte	Maturing
Macrophage	Sinusoid
Red Blood Cell	Membrane
Fibroblast	Membrane Structure
Cell	
Migration	

Date Search Received: October 5, 1967

Number of Hits: 203

Date Documents Requested by Researcher: December 14, 1967

Number of Documents Requested & List of STAR Numbers: 11

A67-81098	A65-81453
A67-81093	A65-81174
N67-16786	
A66-80214	A64-81287
A66-31394	A64-80759
N66-31395	
N66-29686	

Degree of Relevance to Problem: Not known yet.

Plans for Use of Information:

COMPUTER EVALUATION REPORT

Biblio. # 1094

Problem Name & Number:

Title Search & RDC Number: Measurement of Oxygen and Carbon Dioxide in Blood and in Expired Air 0395

Date Search Initiated: December 11, 1967

Descriptors:

Measurement	Carbon Dioxide Concentration	Measuring Apparatus	
Partial Pressure		Blood	
Respiration	Analytical Chemistry	Blood Circulation	
Expired Air	Qualitative Analysis	Circulatory System	
Alveolar Air	Quantitative Analysis	Hypercapnia	
Exhalation	Volumetric	Hypocapnia	
Respiratory System	Analyzer	Hypoxia	
Oxygen Sensor	Gas Analyzer	Hypoxemia	Hyperoxia
Oximeter	Gas Composition	Oxygen	Carbon Dioxide

Date Search Received: December 15, 1967

Number of Hits: 262

Date Documents Requested by Researcher:

Number of Documents Requested & List of STAR Numbers:

Degree of Relevance to Problem:

Plans for Use of Information:

3.0 FINANCIAL STATUS

A summary of contract expenditures for the period 1 September 1967 through 1 November 1967 is presented in Table I.

COST SUMMARY

Quarterly Costs:	
Direct Labor	$11,466.00
Overhead	10,933.00
Direct Costs	890.00
Fee	1,395.00
Total Quarterly Costs	$24,684.00

APPENDIX A

Contribution Evaluations

MEDICAL PROBLEM REPLY REPORT

Center: Langley Research Center

Contributor: John Samos, Dan Popma

Problem No. & Title: UNC - 1 Oxygen Measurement in Gas Mixtures

Evaluation: First contact was a telephone conversation between John Samos and H. G. Richter--outlining details of problem since Samos did not have copy of original UNC - 1. Then conversation between Dan Popma and H. G. Richter transpired wherein Popma suggested a commercial device which he thought would work, the Beckman paramagnetic oxygen analyzer.

Dr. K. Sugioka, Department of Anesthesiology, UNC, has one of the Beckman instruments. He does not use it often, does not like it. Whereas it measures oxygen accurately and rapidly and does the job he wants, he considers it to be too delicate an instrument for the operating room; it must be calibrated daily and is too expensive to equip each operating room suite with one.

Plans for Use: None

MEDICAL PROBLEM REPLY REPORT

Center:

Contributor: Dr. Harold G. Richter, RTI Biomedical Applications Team

Problem No. & Title: UNC - 9 Analysis of Electrophoretic Scan Data

Evaluation: A method for counting hundreds of radioactive electrophorus samples. Prior to this transfer Dr. Van Wyk was measuring areas of curves from radioactive chromatogram scanner. Method was tedious and very time consuming. Data were weeks or one month in being analyzed--frequent errors occurred. New technique is automatic and finished within 24 hours.

Plans for Use: Dr. Van Wyk will use this method routinely from now on.

APPENDIX B

Biomedical Problem Abstracts

BIOMEDICAL PROBLEM ABSTRACTS

WF-28

"Blood Flow Volume and Blood Flow Rate in Vascular Systems Using Indicator Concentration Methods"

Prepared for

National Aeronautics and Space Administration
Technology Utilization Division
Washington, D. C. 20546

"This problem abstract is designed to call to the attention of NASA personnel (and others who have agreed to participate) significant barriers that impede the progress of biomedical research and health care. The purpose is to bring to bear on these problems the expertise that resides in NASA. If you feel you can make a contribution, please communicate your suggestions to the Technology Utilization Officer at your installation. Also, alert him to any suggestions which can constitute inventions so that patent application may be made. Thank you."

Problem Abstract

WF-28
October 1967

Background

The use of indicator concentration curves to compute mean flow through and the volume of blood contained in a portion of the vascular system is an attractive technique. Much theoretical and experimental work has been done in this area. Researchers at Bowman Gray School of Medicine, Wake Forest University, have been engaged in an experimental program to accurately define the methods and techniques which can be used to obtain reliable data from these types of measurements. Because of the complexity of biological systems, initial studies have been made using a model in which an indicator, dye or radioactive, is injected mechanically at a constant rate into a uniformly flowing stream of blood in a plastic tube of uniform diameter. The time of injection can be varied in order to control the amount of dye injected. The injection rate is 0.01 cm^3 of indicator per second. The injection time can be varied from one-tenth second up to about 10 seconds. The range of volumetric flow of the fluid in the tube is between 2.5 and 25 cm^3/minute (flow velocity of 0.3 cm/second to 3 cm/second). Downstream from the site of injection is a counter or photocell, depending upon the type of indicator used, whose output is recorded on a strip chart. The output of the detector is proportional to the concentration of the dye or radioactive substances in the stream. Under experimental conditions flow is maintained laminar or streamlined. Because of this flow characteristic, the injection of dye is exceedingly critical depending upon whether the injection point is near the center of the tube or near an edge of the tube.

To overcome this problem in the model system, a rotary, magnetically operated mixer is installed immediately upstream from the injection site. This mixer induces turbulence, breaking up the laminar flow so that in the region of the injection site, the fluid flow is turbulent. Therefore, the velocity is approximately uniform across the entire diameter of the tube just below the mixer. Laminar flow is soon restored in the tube and makes it necessary to use another mixer at the sampling site. This occurs because the counter has a finite aperture. If one considers equal quantities of indicator which are traveling at different speeds, it is easily seen that the slower moving fluid will remain for a longer period of time under the counter aperture, therefore producing more counts than the rapidly moving indicator. This means that indicator concentration is biased so that equal concentration and lengths of laminae of indicator fluid do not produce the same number of counts; i.e., a fixed volume and a fixed concentration of indicator fluid moving at a higher rate produces fewer counts than the same volume and the same concentration of indicator moving at a lower rate.

To overcome this measurement difficulty, a mixer has been placed in the experimental apparatus upstream from the sampling site. This produces turbulence, thoroughly mixing the indicator components which were traveling at different velocities in the laminar flow region, so that the velocity of all

Problem Abstract
Page 2 of WF-28 (Cont'd)

the indicator is approximately the same as it passes under the counter aperture. Without the use of mixers to produce turbulence at both the injection and the sampling sites, it has not been possible to obtain reliable data on blood rate of flow and volume.

Needed

In order to make the transition from the idealized model, with which reliable data may be obtained, to measurements on a biological system, some means of inducing thorough mixing immediately preceding the injection and sampling sites is needed. This type of measurement would normally be conducted in arteries or veins near the surface of the skin. A simple device which can be employed to produce mixing and turbulence at the injection site and the sampling site in the veins and arteries is needed. An allied problem associated with the same experiment involves the injection of indicator into the vein or artery. Twenty-two gauge needles having an inside diameter of 0.016 inch are used to inject the dye. The cross-sectional area of such a needle is 0.0013 square centimeter. The area exposed to the fluid stream is, however, larger than this because the needle tip is cut at an angle to obtain a sharp point for insertion into the vein or artery. Nominally, approximately 0.01 cm of indicator is injected. There is an undetermined amount of washout from the needle tip so that more indicator is injected into a stream than is desired, and the injection pulse continues for a short period of time after the hypodermic syringe is deactivated. A method of injecting exact amounts of indicator and eliminating washout at the tip of the hypodermic needle is very desirable.

For more information contact

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Source of problem

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